DESCRIPTION OF A ROTARY CAMPIMETER

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The object of this apparatus is to add to the vertical campimeter the rotary features of the perimeter, and thus to allow investigation of every possible meridian of the retina with as much ease and precision as was possible with the old form of campimeter in the nasal meridian only, or at most, in the nasal and temporal meridians. The apparatus consists of two parts, with appropriate supports and accessories; a stimulus screen, and a campimeter screen which rotates on a collar around a circular support. The stimulus is exposed through an opening in the center of the campimeter screen. One arm of the framework of this screen carries the fixation-points and also a right-angled extension which allows fixation to be given at an excentricity of 92°. This arm may be rotated to any position desired; and thus any meridian of the retina may be explored. In order that the sensation received in the peripheral retina may be accurately expressed in terms of color- and brightness-values of the central retina, the fixation-arm of the screen is further provided with a small detachable motor upon which may be rotated the proper combination of discs for matching the peripheral sensation. This increases greatly the definiteness of work on the sensitivity of the peripheral retina. The feature was added to the apparatus so that complete maps might be made of the changes in the sensitivity of the retina from center to periphery and from one meridian to another, with tables showing the value of the changes from point to point.

Photographs of the skeleton apparatus and of the front and back views of the campimeter, in readiness for use, are appended.

Figure 1 shows the skeleton apparatus. It consists of the following parts: Supporting base, frame for campimeter screen, and frame for the stimulus card. The supporting base consists of a horizontal steel bar, 83 cm. long, supported by two iron tripod rests (B and B′). To this bar are clamped two uprights (C and C′), which are adjustable along its length. The anterior upright (C) supports the frame on which the background of cardboard and the campimeter screen (D) are fastened. The posterior upright (C′) supports the stimulus frame (E). The height from

the table of each of these frameworks is adjustable by means of set-screws (F and F′). The framework for the campimeter screen consists of a central support and radiating arms. The central support consists of a stationary brass ring, about which rotates a larger brass collar (H), 20 cm. in diameter.[1]

The back surface of collar (H) is graduated from 0° to 360°. To this collar are fastened the radiating arms. There are eight of these arms, one for each 45° mark of the graduated collar. They are made of steel and are 2 cm. broad and 40 cm. long. The eighth arm (I and I′) differs from the other seven. It forms a right angle, one side of which lies in the plane of the background, and the other in front of this plane. The part in the plane of the background is 30 cm. long, and the part at right angles to this plane is 28 cm. long. The arm is graduated from 18° to 57° along the section that lies in the plane of the background and from 57° to 92° along the section at right angles. The graduations are based on the arc of a circle of 25 cm. radius. The arm is also split lengthwise to form two narrow arms, each 1 cm. wide, so separated that there is an opening (J) 0.8 cm. in width between them to admit the shank of the motor for rotating the discs needed to match the peripheral sensation. The opening to admit the shank of the motor may be clearly seen in all the pictures of the campimeter. The motor is shown at K, on the right of Figure 1, and more clearly on the left of Figure 3. It has a shank 4 cm. long, and 0.3 cm. in diameter, which can readily be thrust through the opening (J). The weight of the motor is so great that it can not be clamped to the arm (I-I′) and be shifted with the arm as the retina is tested in different meridians. It has then to be supported so that it can readily and quickly be moved to any point in any meridian to which the arm (I-I′) may be rotated. This is accomplished by the use of two rods—one vertical and the other horizontal (M). The vertical rod (L) may be clamped to the table

[1] This ring was made large in diameter for two reasons. (a) The ring had to be made very thick in order to give sufficient rigidity to support the campimeter screen and to furnish proper attachment for the rotary collar. Had the circumference been small, the effect of the ring would have been that of a short tube. If the stimulus were viewed through a short tube, an induction factor would have been involved which would have been difficult, if not impossible, to standardize. The opening in the ring was, therefore, made considerably larger than any stimulus we wished to use in order to avoid the introduction of this factor. (b) The large circumference of the ring makes the apparatus available for investigating the effect upon sensitivity of varying the size of the stimulus.

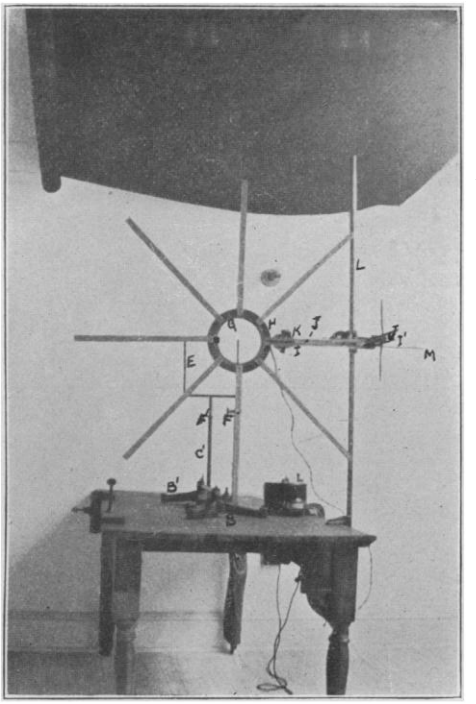

FIG. I.

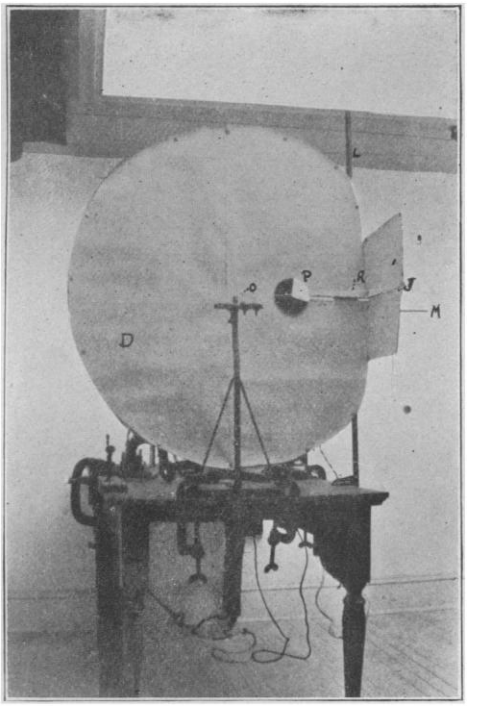

FIG. II.

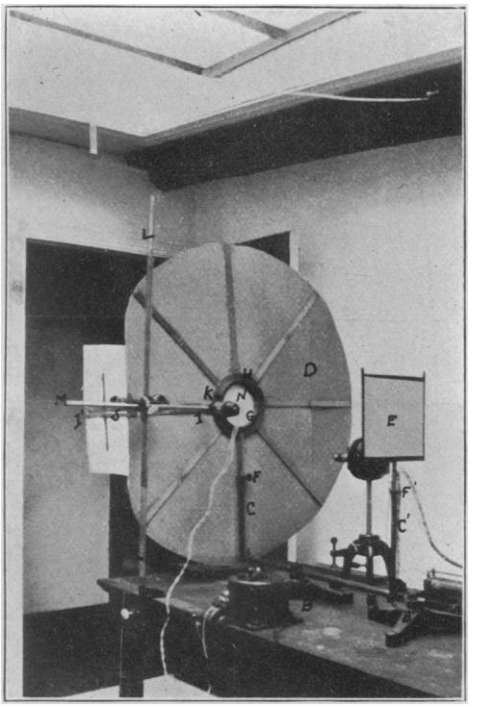

FIG. III.

or other support on either side of the campimeter, and M is clamped to L. The vertical adjustment for any setting of the motor can thus be made along L, and the horizontal adjustment along M. Holes are punched in each of the eight arms at six or more places to allow the insertion of small metal fasteners to hold the background screen to the frame. The stimulus frame may be seen at E. It is 20 cm. square and carries a groove for the insertion of the stimulus card. The stimulus card may be made of whatever colored paper the experimenter desires to use.

Figure 2 shows the front view of the campimeter in readiness for use, and Figure 3, the back view. A card-board background has been fastened to the steel arms by means of paper fasteners. Since the background is fastened to the arms attached to the brass collar (H), a circular gap is left at its center. This gap is filled by a disc (N), shown in Figure 3, which has been fastened to the arms just outside of the collar (H). The disc is 27 cm. in diameter, and contains the stimulus opening (O), the size of which may be varied to accord with the purpose of the investigation. In order to complete the graduations on the fixation-arm to the stimulus opening, disc (N) is graduated from 0° to 18°. A background 40 cm. in height is fastened to the extension arm (I). In the picture a paper screen made of No. 7 of the Hering series of grays has been attached by thumb tacks to the card-board background.[2] A strip of paper of the same quality as the background is placed along the opening (J), and the graduations from 0° to 92° are pricked on this strip at points determined by the markings on the back of disc (N) and arm (I-I′). These constitute the fixation points. The card in the stimulus frame (E) is seen through the opening (O). A disc (P) composed of black and white sectors has been placed on the motor (K).

The method of using this apparatus is as follows: The observer is seated in front of the campimeter-screen with his head held in a rigid position by means of a mouth-board bearing the impression of the teeth in sealing wax. Since the graduations of the fixation-arm are based on the arc of a circle of 25 cm. radius, the distance of the eye from the stimulus opening is chosen as 25 cm. The position

[2] In all tests of the relative and absolute sensitivity of the retina this screen should be made of a gray of the brightness of the color to be used. No departure from this rule should be permitted unless it is for the purpose of determining the effect of different screens on the sensitivity of the retina, or of using this effect as a means of varying sensitivity.

of the eye in the observing plane may be obtained according to the method described by Fernald.* In order to facilitate eccentric fixation in the nasal and temporal meridians, the head should be turned 45° nasalwards or temporalwards, as the case may be. With the head so placed, the eye can swing easily from the stimulus opening to a fixation-point whose eccentricity exceeds 90°. The unused eye is closed and covered by a bandage. The arm (I-I′) is placed in the meridian desired, the position being determined by the graduations on the collar (H). The experimenter covers the stimulus in the stimulus frame with a card, which we shall call the pre-exposure card,[3] while the observer takes the fixation required. At a signal given by the observer, the pre-exposure card is withdrawn, the stimulus is exposed for three seconds, and the pre-exposure card is replaced over the stimulus. The observer is required to rest the eye after each observation. Further provisions against fatigue are made by periods of rest after each fifteen minutes of observation.

When it is desired to measure the stimulus as seen in the peripheral retina in terms of the brightness- and color-values of the central retina, the motor shown at K in Figures 1 and 3 is used. The method of making the measurement is as follows: If a direct vision judgment, for example, of the appearance of yellow at 25° in the temporal meridian is wanted, the cord (R) carrying a movable fixation-point, seen in Figure 2, is fastened in front of the 25° point on the graduated background. The observer, in position, fixates the 25° point and brings the movable point in line with the eye and the 25° point. This point then serves as the new fixation-point, and the graduated strip covering the opening (J) is removed. The required discs are placed on the motor immediately behind the new fixation-point, and their proportions are changed until the observer judges that the sensation aroused in the periphery is matched by that aroused in the center by the measuring-disc on the motor. In making this judgment, the method of ascending and descending series should be used.

This apparatus was designed two years ago. The object at that time was, in general, to make an exhaustive study of retinal sensitivity to colored light in a large number of

* FERNALD, G. M.: The Effect of Achromatic Conditions on the Color Phenomena of Peripheral Vision. *Psychol. Rev., Monograph Supplements,* X, 1909, p. 18.

[3] In all investigations of relative or absolute sensitivity, this pre-exposure card also should be made of a gray of the brightness of the color to be used.

meridians. Early in this work, however, the need for more adequate standardization was recognized. The problem of standardizing was divided into two parts: the source of light, and the factors extraneous to the source of light. The apparatus described above was designed especially for the standardization of the factors extraneous to the source of light. Pigment papers were used in this work as a source of light because they are fully adequate to the needs of the problem, and are besides much more convenient than spectral light for many of its details. The apparatus was thus especially devised for the use of pigment papers. About nine months ago, however, the standardization of the source of light was begun. This required, on the qualitative side, that light of spectral purity be used; and on the quantitative side, that the lights be measured in terms of units that can be compared, i. e., in terms of energy or radiometric units. The apparatus has been remodeled and supplemented to meet these needs. A description of the revised apparatus together with the supplement for radiometric measurements will be given in a later paper.